Rehabilitation Techniques to Improve Long-term Performance of Highway-Railway At-Grade Crossings

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Purpose

• Smooth Surface

• Safe Passage of Rubber-Tired Vehicles Across the Railroad
Ideal

• Stay Smooth and Stable for Long Period of Time

• Reduce Costly Interruptions to Rail and Highway Traffic

• Improve Operating Performance
Ideal

• Rapidly Install/Renew

• One Day (RR 4 hrs/Hwy 8-12 hrs)

• Layered Support

• Premium Materials
Procedure

- Complete Rebuild
- Support Layer
- Pre-Compacted Ballast
- New Track Panel
- New Crossing Surface
Ideal

• Cooperative Effort

• Local Hwy agency and RR Company

• Reduce Costs/ Improve Quality/ Minimize Disruption
• Procedures/Case Studies

• Pressure Measurements—On Surfaces within Layers

• Long-Term Settlements
• Deteriorate

• Low Ride Quality
R-O-U-G-H
• Typical Granular Crossings
• Excessive Deflections
  ¼ inch (6mm)
• Structurally Dissimilar
Permanent Settlement

- Impact Loadings
- Low Spot
- Impaired Drainage
- Deterioration
- Rehabilitated
Ideal

• Adequate Strength and Support
• Minimize Deflections
• Reduce Permanent Deformations
• Waterproof
• Long-Life, Smooth Crossing
Consensus Goals -- Ideal Crossing Renewal Management Program

- Quality, Safe, Cost Effective, Stable, Smooth, Serviceable
- Minimum of Disruption 4 hr. train/8-12 hr. Highway closures
- Cooperative, Cost-Sharing, Minimum Expense
Planning Meeting

Railroad Company and Governmental/Highway Agency

- Select Date

Rail Volume/Schedule

Highway Volume/Critical/Detours
• Assign Responsibilities

– Highway Closure and Traffic Control
– Public Announcements/Notifications
– Railroad Curfew
– Temporary Crossing/Detour
– Track/Surface Remove and Replace
– Highway Paving
• Share Cost

Removal and Installation of Track and Crossing  
(Materials, Labor and Equipment)

Traffic Control, Public Announcement, Highway Paving
• FAST-TRACK CASE STUDIES

• COSTS AND ECONOMICS

• TESTS AND PERFORMANCE MEASURES
Excavating trackbed and checking grade

Removing old crossing 08:30

KY 303 Condition prior to rebuild

Began excavating

Excavating trackbed and checking grade
Dumping asphalt 10:15

Spreading asphalt

Compacting asphalt and dumping ballast

Dumping and spreading ballast
3 weeks later

Compacting hand-spread approaches

Regulating ballast 12:40

Finished compacting asphalt approaches 16:50

3 weeks later
Costs and Economics

Asphalt=$60/ton delivered

½ ton/tk ft (6 in. thick, 12 ft. wide)

$30/tk ft X 80 ft = $2,400

Underlayment

Crossing Renewal

≈ $10,000—$40,000
TESTS AND PERFORMANCE MEASURES

- Trackbed Pressure
- Surface Pressure
- Long-Term Settlement
Pressure Cell

- Geokon Model 3500-2
- 9 in. Diameter
- Strain Gage
- Snap-Master
- Thermistor

Cell Placement on Asphalt
Cell Location at Richmond
Loaded Coal Train at Richmond

P-Cell 819 Beneath Rail in Crib

P-Cell 820 Beneath Rail and Tie

P-Cell 821 C/L Track in Crib

P-Cell 822 C/L Track and Tie

2 6-Axle Locomotives
Initial 2 Cars

Loaded Coal Train at Richmond

P-Cell 819 Beneath Rail in Crib

P-Cell 820 Beneath Rail and Tie

P-Cell 821 C/L Track in Crib

P-Cell 822 C/L Track and Tie

2 6-Axle Locomotives
Initial 2 Cars
Loaded Auto Train at Richmond

P-Cell 819 Beneath Rail in Crib

P-Cell 820 Beneath Rail and Tie

P-Cell 821 C/L Track in Crib

P-Cell 822 C/L Track and Tie

Initial 2 Cars

1 6-Axle Loco

1 4-Axle Loco

Pressure (psi)

Time (s)
Loaded Concrete Truck at Richmond

![Image of a concrete truck at Richmond]

**P-Cell 820 Beneath Rail and Tie**

![Graph showing pressure over time]

- Time (s)
- Pressure (psi)
Cell Location at Lackey
Loaded Coal Train at Lackey

P-Cell 510 Beneath High Rail and Tie
- 2 6-Axle Locomotives
- Initial 2 Cars

P-Cell 511 Beneath High Rail and Tie
- 2 6-Axle Locomotives
- Initial 2 Cars

P-Cell 806 C/L Track and Tie
- 2 6-Axle Locomotives
- Initial 2 Cars

P-Cell 207 Beneath Low Rail and Tie
Empty Coal Train at Lackey

P-Cell 510 Beneath High Rail and Tie

Pressure (psi)

Time (s)

2 6-Axle Locomotives  Initial 2 Cars

P-Cell 511 Beneath High Rail and Tie

Pressure (psi)

Time (s)

2 6-Axle Locomotives  Initial 2 Cars

P-Cell 806 C/L Track and Tie

Pressure (psi)

Time (s)

2 6-Axle Locomotives  Initial 2 Cars

P-Cell 207 Beneath Low Rail and Tie

Pressure (psi)

Time (s)

2 6-Axle Locomotives  Initial 2 Cars
Flat Wheel on an Empty Coal Train at Lackey

P-Cell 511 Beneath Rail and Tie

2 6-Axle Locomotives
95 Empty Cars
Loaded Coal Truck at Lackey
• Matrix-based array of force sensitive cells
• Silver conductive electrodes
• Pressure sensitive ink – Conductivity varies
• Crossing of ink – strain gauge

View of Tekscan Sensors

Tekscan Measurement Configuration
Rear Tires of Tractor of a 151,000 lb Loaded Coal Truck on Concrete Crossing of Kentucky Coal Terminal, Mile Post 6.6. May 25, 2004

9842 lb

135 psi

72.93 in^2
Front Tire of a CSXT Suburban on Asphalt Parking Lot in Ashland Oil Company.
May 25, 2004

1652 lb
75 PSI
22.15 in^2
Rear Tire of a CSX Suburban on Asphalt Parking Lot in Ashland Oil Company.
May 25, 2004

2197 lb
81 PSI
27.15 in^2

Force vs. Frames
Pressure vs. Frames
Typical Pressures on Asphalt

- 286,000 lb
  - 13 - 17 psi
    - Loaded

- 62,000 lb
  - 2 - 4 psi
    - Empty

- 180 lb
  - 6 psi
    - Actual

- 150,000 lb
  - 125+ psi
    - Loaded
Long-Term Trackbed Settlement

Longitudinal view of highway/rail crossing containing asphalt underlayement

<table>
<thead>
<tr>
<th>Station 1</th>
<th>Station 9</th>
<th>Station 12</th>
<th>Station 20</th>
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<td>Crossing Surface</td>
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<tr>
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<td>Asphalt Underlayment</td>
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<tr>
<td>Station 8</td>
<td>Roadbed</td>
<td>Station 13</td>
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Flag Spring
Average Asphalt/Approach Settlement for Flag Spring (no underlayment)

Average Settlements:

- Approach Settlements:
  - 0.97
  - 1.12
  - 1.50
  - 1.74

- Crossing Settlements:
  - 0.52
  - 1.00
  - 1.28
  - 1.69

*Installed 5/13/2002*
Top of Rail Elevations for KY Coal Terminal #2 Track

 Installed 11/14/02
Average Asphalt/Approach Settlement for KY Coal Terminal #2

Installed 11/14/2002

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<th>Time (Months)</th>
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<tr>
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Average Asphalt/Approach Settlement for No Name

Time (months)
Settlement (in.)
Approaches
Crossing
Installed 10/14/2005
Stanley
Average Top of Rail Elevations for US 60 Stanley

Installed 5/16/2002

Station

Elevation (ft.)
Average Asphalt/Approach Settlement for US 60 Stanley

Installed 5/16/2002

Time (Months)
Settlement (in.)
Approaches
Crossing
• Settlement Asphalt Crossings was 41% of non-Asphalt Crossings

• Settlement Asphalt Crossings was 44% of Abutting Approaches

• Settlement of Non-Asphalt Crossings & Approaches – Similar
References

- AREMA (2002) Annual Conference
- TRB (2009) Annual Meeting
- KTC (2009) Reports
  - 136-04-1F
  - 136-04-2F
  - 136-04-3F
Closure

- Current Practices
- Not All-Encompassing
- Typical Activities